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THE BIOLOGICAL BASIS OF NERVOUS TISSUE REPETITIVE STRAIN INJURIES
IN ESPORTS COMPETITORS

by

Katryna Booth-Malnack

A Thesis Submitted in Partial Fulfillment
Of the Requirements for the
University Honors Program

Department of Biology
The University of South Dakota
May 2019

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ABSTRACT

The Biological Basis of Nervous Tissue Repetitive Strain Injuries in eSports Competitors

Katryna Booth-Malnack

Director: Christopher V. Anderson, Ph.D.

Participation in competitive video games, or eSports, is growing. ESports players subject themselves to high-intensity practice sessions over long hours in order to maintain their competitive edge. This may be putting them at risk for developing repetitive strain injuries (RSIs) of the nervous tissue. RSI is an umbrella category for musculoskeletal or nervous tissue injuries caused by repetitive motions, sustained muscular contractions, or abnormal posture. Nerve entrapments are common in occupations with repetitive hand and wrist actions, which may include eSports. Mechanisms of injury of RSIs to the nervous tissue were compared to motions and postures associated with playing video games. The mechanisms of injury were determined to be similar to the motions that cause injury in eSports. This mechanisms of injury comparison, coupled with firsthand accounts from current and former eSports players diagnosed with nerve entrapment disorders, provide preliminary evidence to determine that playing eSports can be linked to RSIs of the nervous tissue. Given the accelerating growth of eSports, the occurrence of resultant RSIs of nervous tissue may increase and therefore benefit from additional study.

KEYWORDS: Repetitive strain injury, injuries of nervous tissue, eSports

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DEDICATION

For E_leet, and all of my current and former teammates in Team Fortress 2.

CHAPTER ONE

Introduction

ESports, or professionally-played competitive video games, is a growing industry with thousands of competitors (Bräutigam, 2015). Though the exact number of competitors across all eSports games is unknown, it is undeniably expanding. For example, the first college eSports program began in 2014, and now there are 125 colleges with similar programs (Morrison, 2019). Similarly, the first World Championship League of Legends tournament in 2011 had eight teams from four regions (Yang, 2018). Participation in the 2018 World Championship tournament increased, with 24 teams competing from 14 regional leagues (Lam, 2018). ESports has even been considered as an addition to the 2024 Olympics because of its popularity with young adults (BBC, 2018).

Playing video games at a professional level requires considerable finger dexterity. The player must perform quick controller button presses and control stick movements, or keyboard inputs and mouse clicks. Every second, the player must move, aim, attack, or perform other game-specific skills requiring accurate and rapid finger movements. ESports players improve their gameplay by practicing on average three to ten hours a day. Prior to tournaments, players typically practice upwards of five and a half hours a day (DiFrancisco-Donoghue et al., 2018). Greg “IdrA” Fields, a former StarCraft II champion said that in 2013, his team, “...played for 12 hours a day with one or two days

off a month," (Stanton, 2015). This level of dedication to a game, however, can lead to painful consequences.

Repetitive strain injuries (RSIs) are a category of injuries to musculoskeletal or nervous tissue caused by repetitive motions, sustained muscular contractions, or abnormal posture (van Tulder et al., 2007). RSIs are often brought about by repetitive motions in one's occupation or hobby. Researchers have investigated a potential link between casually playing video games and RSIs (Zapata et al., 2006). However, the more intense and frequent motions of eSports players has yet to be studied.

Repetitive strain injuries are broadly caused by internal friction and pressure on soft tissues (van Tulder et al., 2007). The tendons and nerves of the hand run through small compartments in the wrist, and are particularly susceptible to RSIs (Shapira and Midha, 2017). Documented RSIs of the hand and forearm include conditions such as carpal tunnel syndrome, de Quervain's tenosynovitis, Guyon canal syndrome, cubital tunnel syndrome, and tendonitis (van Tulder et al., 2007).

The risk of RSIs from eSports may be significant. The extent of injuries occurring in eSports competitors, however, remains scarcely researched. Here, a subset of major RSIs will be reviewed from a biological perspective and their association to eSports will be discussed. This will be accomplished through a literature review comparing known mechanisms of injury in common RSIs to the motions and postures used in competitive video games. The literature review will be further supplemented by first-hand accounts of eSports athletes as examples of occurrence of these injuries.

Repetitive Strain Injuries

Repetitive strain injuries are a category of injuries to musculoskeletal or nervous tissue caused by repetitive motions, sustained muscular contractions, or abnormal posture (van Tulder et al., 2007). The term *repetitive strain injury* is considered controversial, however, due to the unquantified nature of the disorders; the frequency of potentially harmful motions and the intensity of the forces have not been identified (Szabo et al., 2000). Alternative terms describing similar conditions include *cumulative trauma disorders*, *work-related musculoskeletal disorders*, *occupational overuse syndromes*, and *upper limb disorders* (van Tulder et al., 2007; Putz-Anderson et al., 1997; DiCecco, 2010; Sluiter et al., 2001). While *work-related musculoskeletal disorders* or *cumulative trauma disorders* are more widely used terms, the term RSI will be used throughout this literature review because it includes nervous tissue injuries and does not have a confounding definition in another field. General symptoms of RSIs include pain, cramping, aching, crepitus, clumsiness, loss of strength in affected hands, and muscle spasms (DiCecco, 2010).

Repetitive strain injury is not a diagnosis, but an umbrella category of injuries to tendons, muscles, joints, and nerves (Yassi, 1997). Researchers have defined specific disorders in each tissue type and body region, each with different hypotheses for physiological and mechanical mechanisms of injury (van Tulder et al., 2007). For instance, low-intensity loading, irregular motor unit recruitment (Cinderella hypothesis), calcium ion accumulation, and ischemia are some of the possible causes of muscular

RSIs (Visser B. and van Dieën, 2006). Individual RSIs are diagnosed through a combination of patient history, physical examination, and various diagnostic tests (e.g. electromyography and arthroscopy). Provocative tests can also help diagnose specific RSIs (e.g. Finkelstein's test for de Quervain's tenosynovitis; Phalen's test for carpal tunnel syndrome (Hagert and Lalonde, 2018)). With the wide scope of pathophysiology hypotheses to describe in detail, this review will focus specifically on RSIs of nervous tissue.

Repetitive Strain Injuries of Nervous Tissue

Repetitive strain injuries affecting nervous tissue are commonly caused by nerve impingements (pinching of a nerve). The nerves of the hand and wrist are especially vulnerable to nerve impingements due to the narrow compartments the nerves course through (Figure 1). An increase in pressure in a compartment results in a loss of conduction velocity, leading to the symptoms of numbness and pain (Desai et al., 2018). Compression of a nerve over a long period of time can result in a nerve entrapment syndrome (Hagert and Lalonde, 2018). A nerve entrapment syndrome is a chronic condition of numbness, pain, and weakness in sensory and motor innervated structures.

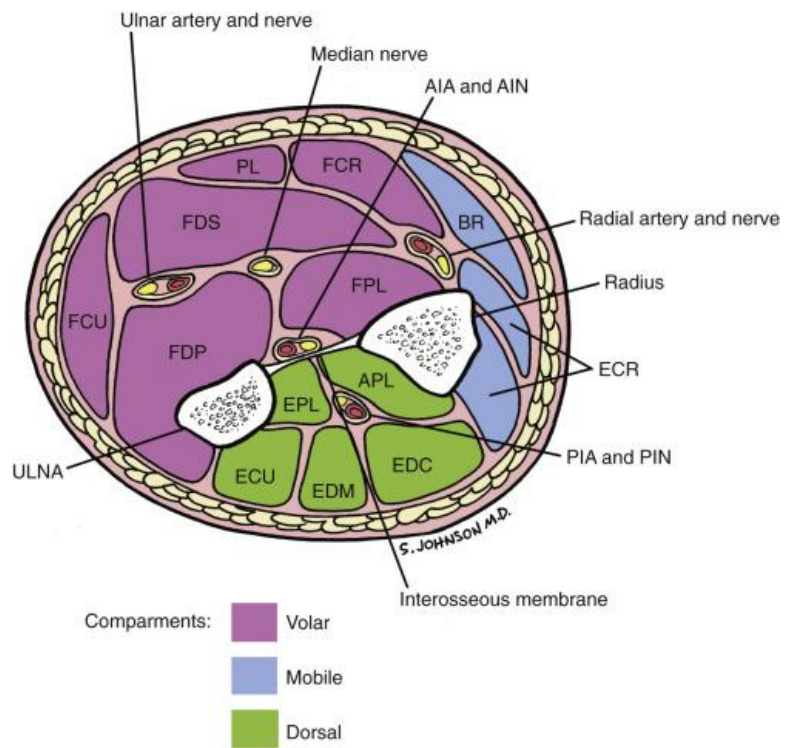


Figure 1. Cross-section view of nerve compartments of the forearm. Figure from Williams and Kim (2018).

CHAPTER TWO

Carpal Tunnel Syndrome

Carpal tunnel syndrome (CTS) is a median nerve entrapment within the carpal tunnel of the wrist (Katirji, 2016). It is the most common nerve entrapment syndrome, and is nearly three times more common in women than men; the likelihood of development of CTS is increased with pregnancy (Desai et al., 2018). This is due to increase of fluid retention during pregnancy causing edema within the carpal tunnel. It is reported as an occupational injury in manufacturing, food processing, and office and administrative work (Desai et al., 2018).

The median nerve runs along the anterior forearm deep to the flexor digitorum superficialis muscle (Figure 2; Drake et al., 2018). This nerve provides motor innervation to the muscles of the anterior compartment of the forearm and thenar muscles of the hand. It also provides sensory innervation to the palm, the palmar surface digits 1-3, and the radial half of digit 4. On the dorsal surface, the nerve also provides sensory innervation to the distal portion of digits 1-3, and the radial half of digit 4 (Figure 3; Epomedicine, 2019).

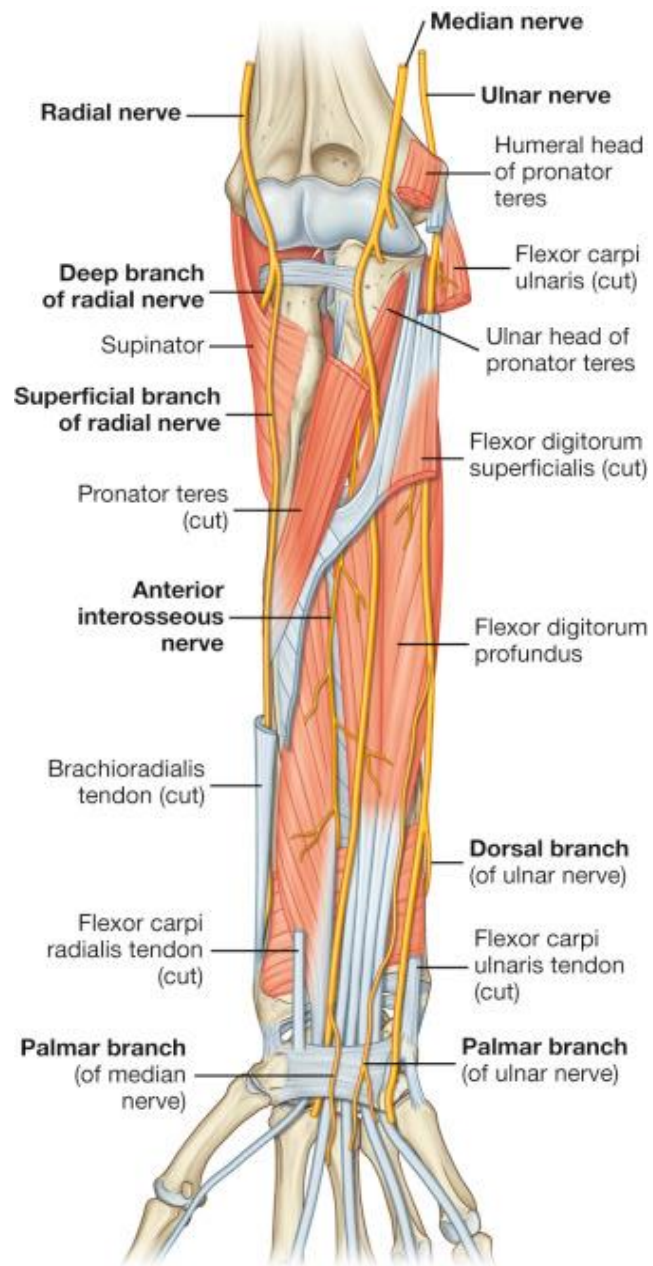


Figure 2. Nerves and forearm muscle anatomy. Figure from Drake et al. (2018).

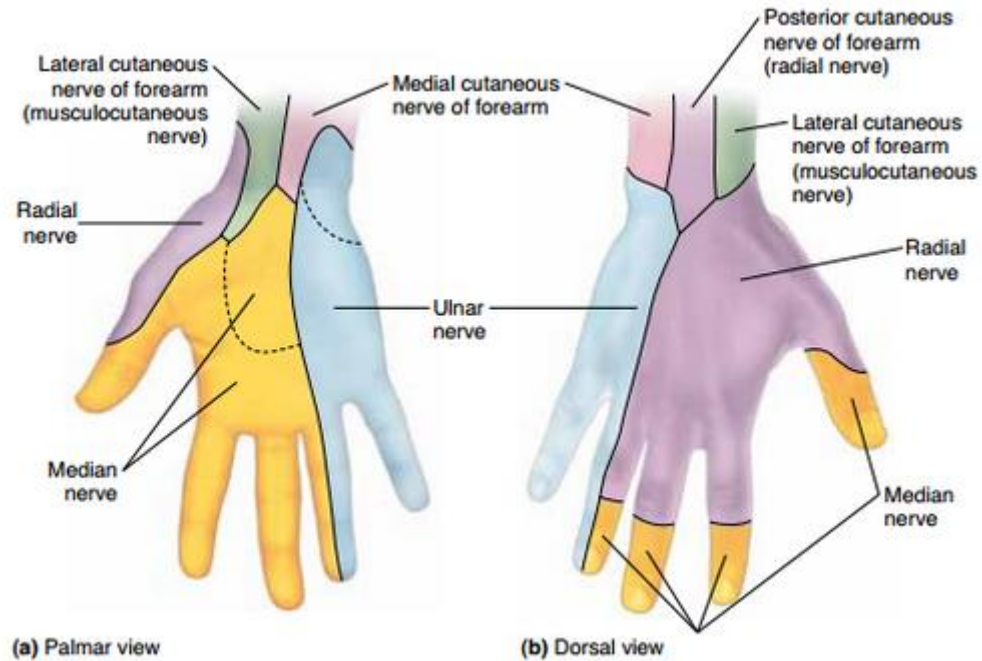


Figure 3. Sensory innervation of the hand. Figure from Epomedicine (2019).

Carpal tunnel syndrome presents with early symptoms of pain and paresthesia (numbness) (Padua et al., 2016). Pain can be localized within the carpal tunnel space or radiating throughout the forearm. In cases with pain radiating through the upper arm and shoulder, double crush syndrome is a concern. This is when there are multiple sites of nerve compression simultaneously (Hagert and Lalonde, 2018). Numbness or tingling sensations are typically located in the first three digits, the radial side of the fourth digit, and the thenar eminence (palm muscles at the base of the thumb). Patients may describe feeling intense temperature sensations. Sensory symptoms occur first, while motor symptoms develop later, usually in the form of weakness in grip strength (Padua et al., 2016). This is due to the progression of atrophy in the abductor pollicis brevis, flexor pollicis brevis, and opponens pollicis muscles. (Ronthal, 2016). Symptoms are often

worse at night, and are exacerbated by repetitive motions or sustained gripping (Padua et al., 2016).

The carpal tunnel space is composed of the distal carpal bones (trapezium, trapezoid, capitate, and hamate) and the overlapping transverse carpal ligament (Figure 4; Ellis, 2008). The median nerve is located between the eight flexor digitorum tendons and the flexor pollicis longus tendon. The transverse carpal ligament is stiff and fibrous, preventing bowstringing (pulling away from the center of rotation rather than following the curvature of bone surfaces they are on; Figure 5.) of the flexor tendons (Martinez, 2013). The contractions of flexor tendons compress the median nerve between the tenosynovium (sheath of tendon that produces synovial fluid) and the transverse carpal ligament.

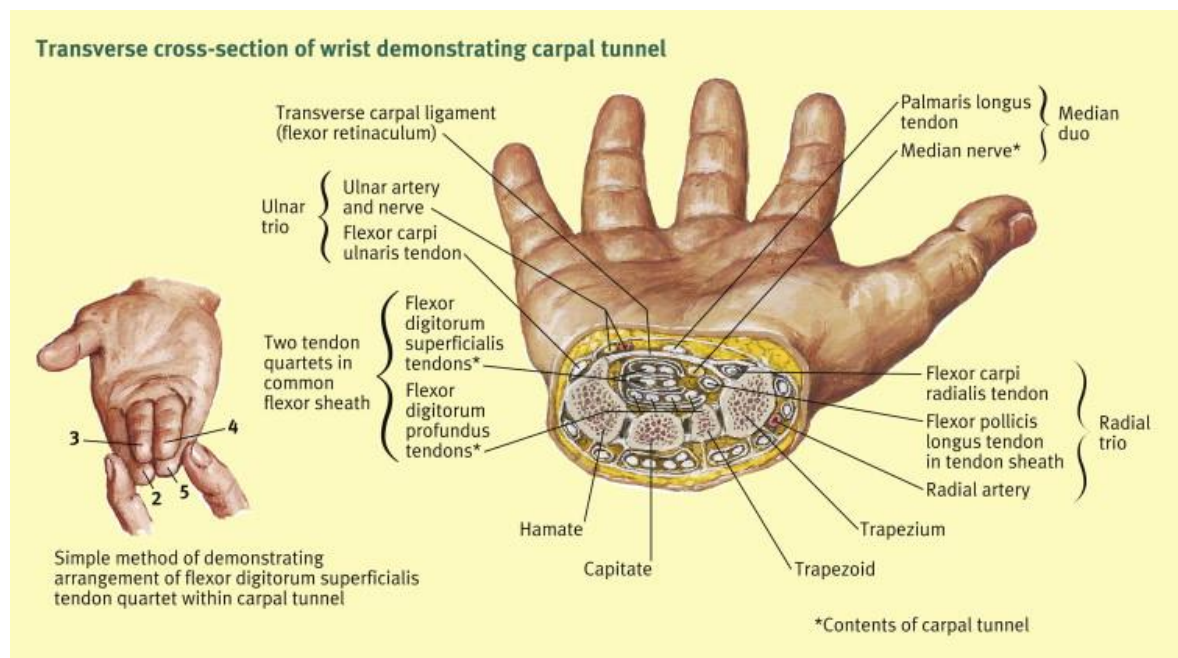


Figure 4. Transverse cross-section of wrist demonstrating carpal tunnel. Figure from Ellis, (2008).

Diagnosis of CTS is determined primarily by electromyography combined with symptom history. Thenar muscle atrophy and ecchymosis (a bluish discoloration of the skin) may be present, but are only visible in extreme cases. Further, Phalen's test (forced flexion of the wrist for a minute) and Tinel's test (percussive forces applied at the entrapment site) may provoke symptoms (Viera, 2003). Another diagnostic characteristic is the "Flick sign." This involves one shaking one's hands or wrists to temporarily relieve numbness (Pryse-Phillips, 1984).



Figure 5. Bowstringing of tendon following opponensplasty. Figure from Chung, (2012).

An increase in pressure on the median nerve results in nerve entrapment. This can be due to narrowing of the tunnel through degenerative conditions such as arthritis, or an increase in the volume of contents within its space (e.g. scar tissue, interstitial fluid). Swollen and inflamed tendons can also increase pressure on the nerve (Desai et al., 2018). In addition, prolonged flexion or extension at the wrist maintains pressure on the median nerve.

The increased pressure within the carpal tunnel leads to physiological and mechanical changes. Ischemia and focal demyelination are both potential contributors to axonal attenuation (loss of function of axons) (Cappelen-Smith et al., 2003). The result in both cases is a reduction in nerve conduction velocity through the carpal tunnel.

Ischemia, or a reduction of blood flow, inhibits the action of sodium/potassium ion pumps in nerves (Han et al., 2009). During ischemia, the less productive sodium/potassium ion pumps leaves axons relatively depolarized and hyperexcitable. Following the release of ischemia, the axon becomes hyperpolarized; the lower resting membrane potential of the nerve means the axon remains in a relative refractory period, and are less susceptible to further voltage-gated actions. This prevents further depolarization, leading to a loss of conduction of sensory or motor impulses (Han et al., 2009). The sustained refractory period preventing further action potentials is a likely cause for the pain and numbness experienced with CTS. Though ischemia is a likely cause of CTS symptoms, mechanical causes have not been ruled out (Cappelen-Smith et al., 2003).

Similarly, myelin increases the speed of conduction of a nerve. The myelin sheath acts as insulation, preventing the diffusion of ions across the membrane. Gaps in the myelin sheath, called the nodes of Ranvier, allow for ion diffusion, which increases the action potential transmission rates as it travels down the axon (Felten et al., 2016). This is called saltatory conduction. Focal demyelination is the degradation of myelin at a specific point. Focal demyelination could result in a loss of conduction velocity through the carpal tunnel. The loss of the myelin sheath around a nerve results in a loss of conduction due to the flow of current out of the membrane (Felten et al., 2016). The symptoms of numbness

and tingling sensations could be indicative of a loss of action potentials within the median nerve.

Carpal tunnel syndrome is a common RSI resulting from motions and postures that compress the carpal tunnel. The mechanisms of injury are repeated or sustained wrist flexion and extension. Occupations with high incidence of CTS include manufacturing and production, material moving, and office and administrative support (Jackson et al., 2018). These occupations include frequent wrist flexion and/or extension.

Though CTS is often associated with occupational computer use, studies have found the link between frequent typing in one's occupation and CTS inconclusive (Thomsen et al., 2008; Andersen et al., 2003). However, unlike conventional computer occupations, the high-intensity practice, fast pace, and long hours of PC-based eSports lead to more repetitive flexion and extension of the wrist (mouse hand) and sustained wrist extension (keyboard hand) than when only typing. In addition, the repetitive finger movements for clicking and keystrokes could cause an increase in pressure in the carpal tunnel space, especially through inflammation and injury of the flexor digitorum superficialis and flexor digitorum profundus tendons. In PC eSports, the player's keyboard hand will rest on the most commonly pressed keys. The control layout will depend upon the movement controls of the game. For games that use the keyboard for in-game character movement, the hand will rest around the standard movement keys of WASD (Figure 6). If a game uses the mouse for in-game character movement, the resting keys will typically be QWER (Figure 6). The mouse hand will rest on the mouse, either in a standard grip or in a claw grip (Figure 7). The resting position of the mouse and

keyboard wrists, especially during WASD and claw grip, are comparable to the wrist postures in occupations with a higher risk of CTS (Figure 8).

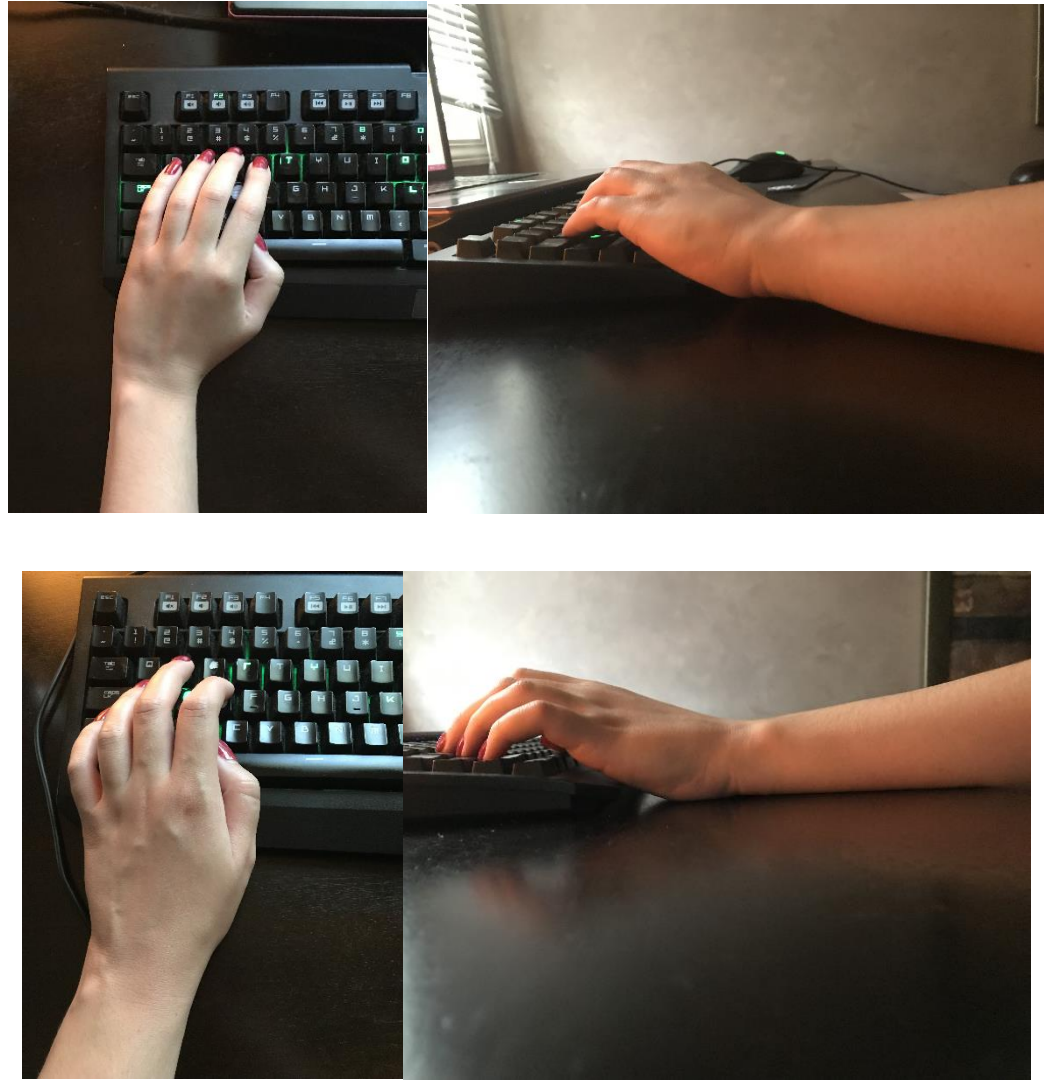


Figure 6. Standard WASD and QWER hand resting positions. In QWER, the forearm is often more bent at the elbow in order to straighten the wrist.

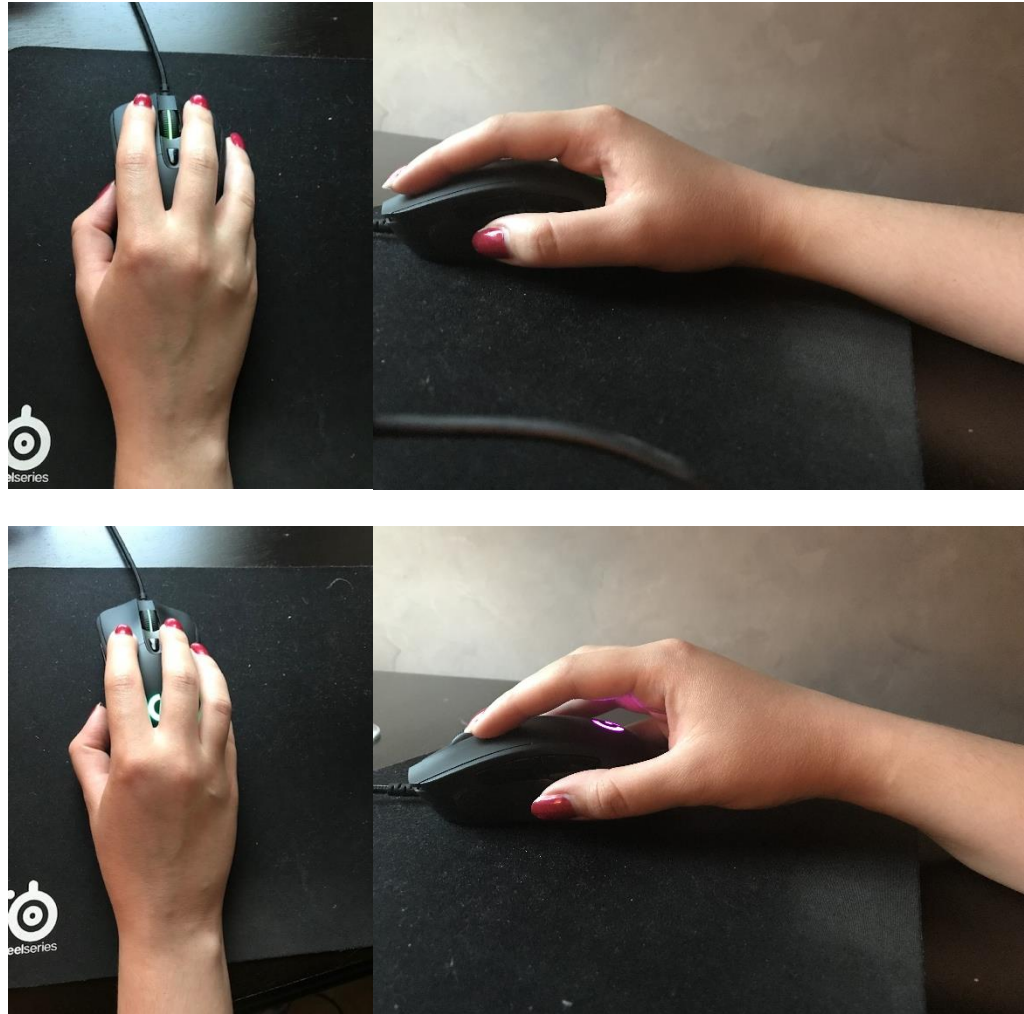


Figure 7. Standard (above) and claw (below) grips of mice. In a claw grip, only fingertips rest on the mice.



Figure 8. Wrist extension in other occupations. Figure from Pinngam (2017) (left) and Luskin (2017) (right).

An example of CTS in an eSports athlete is League of Legends player Lau "Toyz" Wai Kin. In multiplayer online battle arenas (MOBAs), such as League of Legends, players use their mouse to control their character movement. Players must constantly move and click their mouse to direct their characters to favorable battlefield positions. In addition, their keyboard hand controls a variety of attacks, abilities, and items a player uses frequently in the QWER arrangement. This requires the repetitive contraction of the flexor digitorum muscles, while the wrist remains flexed, resulting in the strain of the tendons in the carpal tunnel; the mechanisms of injury align with these actions and posture.

Wai Kin stated "I had been practicing more than 10 hours a day and started to feel numbness and pain in my wrist. . . I was diagnosed with carpal tunnel syndrome" (Wai Kin, 2013). In 2013, he retired from League of Legends. Though he has made an attempt to return, CTS has kept him from playing competitively (Kresse, 2015).

CHAPTER THREE

Cubital Tunnel Syndrome

Cubital tunnel syndrome is an ulnar neuropathy caused by the compression of the ulnar nerve at the cubital tunnel located on the medial side of the elbow (Mackinnon and Novak, 2017). It is the second most common nerve entrapment syndrome of the forearm behind CTS. Compression within the cubital tunnel is caused by repetitive or sustained elbow flexion, which is worsened by resting the elbow on hard surfaces. Scar tissue can increase of volume within the tunnel. Injury, or musculoskeletal conditions can contribute to the narrowing of the cubital tunnel.

In order to understand cubital tunnel syndrome, it is important to describe the anatomy of the cubital tunnel. The floor of the cubital tunnel is composed of the posterior aspect of the ulnar collateral ligament (ligament connecting humerus and ulna) and elbow joint capsule. The medial epicondyle of the humerus and olecranon of the ulna are the medial and lateral walls, respectively (Figures 9-10). This means the ulnar nerve runs along the medial side of the elbow. The ceiling is formed by the Osbourne ligament or the cubital tunnel retinaculum. The cubital tunnel retinaculum can be absent, thin, or thick (O'Driscoll et al., 1991). In addition, an accessory anconeus epitrochlearis muscle may be present following the same pathway as the cubital tunnel retinaculum.

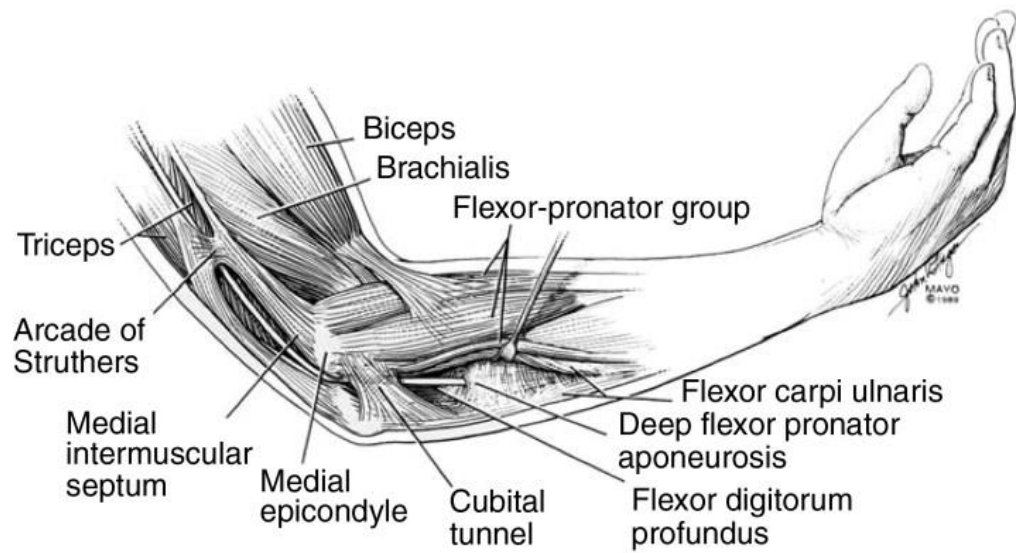


Figure 9. The cubital tunnel. Figure from Palmer and Hughes (2013).

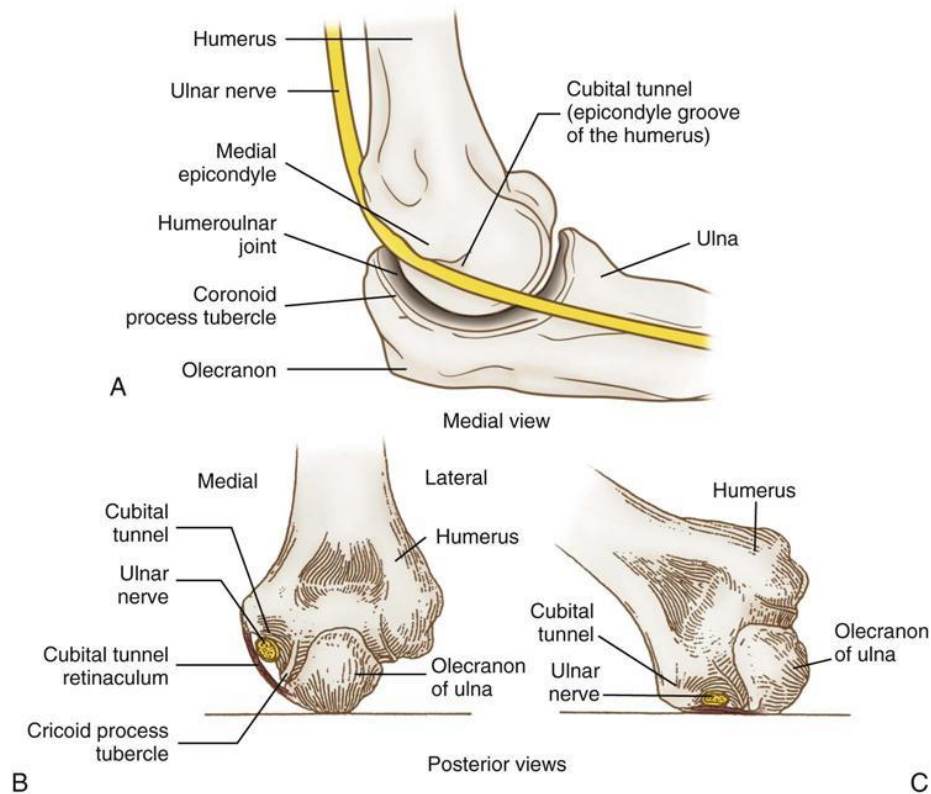


Figure 10. Medial and posterior views of the cubital tunnel. Figure from Heizenroth (2016).

The ulnar nerve travels from the cubital tunnel of the elbow down the ulnar side of the forearm. From there, it branches within the Guyon canal on the ulnar side of the wrist. The deep ulnar nerve supplies the motor input for the interossei (dorsal intrinsic muscles in between fingers) and lumbricals (ventral intrinsic muscles between fingers) of the ulnar side of the hand while the superficial ulnar nerve provides the ulnar half of the fourth and the fifth digit with sensory information.

Compression of the nerve within the cubital tunnel leads to weakness, pain, and/or paresthesia of the ulnar half of the fourth and the fifth digit, as well as weakness of the interossei and lumbrical muscles. Tinel's test at the cubital tunnel is likely to provoke symptoms. Like CTS, diagnosis is primarily based on electromyography in conjunction with symptom history.

Like CTS, an increase of pressure within the cubital tunnel interferes with nerve conduction. However, because the cubital tunnel contains only the ulnar nerve and fat, cubital tunnel syndrome is unlikely to be induced by an increase of the volume of contents within the tunnel. Instead, it is typically caused by sustained flexion of the elbow (Ronthal, 2016). In addition, a thick cubital tunnel retinaculum or the presence of the anconeus epitrochlearis may increase one's risk for cubital tunnel syndrome by increasing pressure in the cubital tunnel during flexion (Park et al., 2018).

The pathogenesis of the cubital tunnel syndrome is likely similar to CTS. The increase in pressure from sustained flexion, or from the presence of a thick CTR or anconeus epitrochlearis, can cause ischemia to the nerve or focal demyelination resulting

in axonal attenuation (Cutts, 2007). Both potentially contribute to the numbness, pain and weakness of fingers innervated by the ulnar nerve.

The most influential occupational risk for cubital tunnel syndrome appears to be sustained or repetitive elbow flexion while holding or grasping objects such as tools (Descatha et al., 2004). It is likely that workers with occupations that require considerable driving time or work with vibrating tools are at increased risk (Pisquiy et al., 2018). Because of this, truck drivers, mechanics, and assembly line workers appear to have a heightened risk (Pisquiy et al., 2018; Descatha et al., 2004).

In both console and PC eSports, it is common for players to maintain elbow flexion. For console eSports, players sustain elbow flexion to hold their controller. In PC eSports, elbow flexion is used to rest their hands on their mouse and keyboard. It is common for console eSports players to rest their elbows and forearms on surfaces while holding their controllers upright (Figure 11). For PC games, the elbows remain relatively more extended with forearms resting on a surface (Figure 12). In both cases, the elbow posture is similar to those of occupations with higher cubital tunnel syndrome risk (Figure 13).



Figure 11. Elbows resting on hard surface while holding controller.

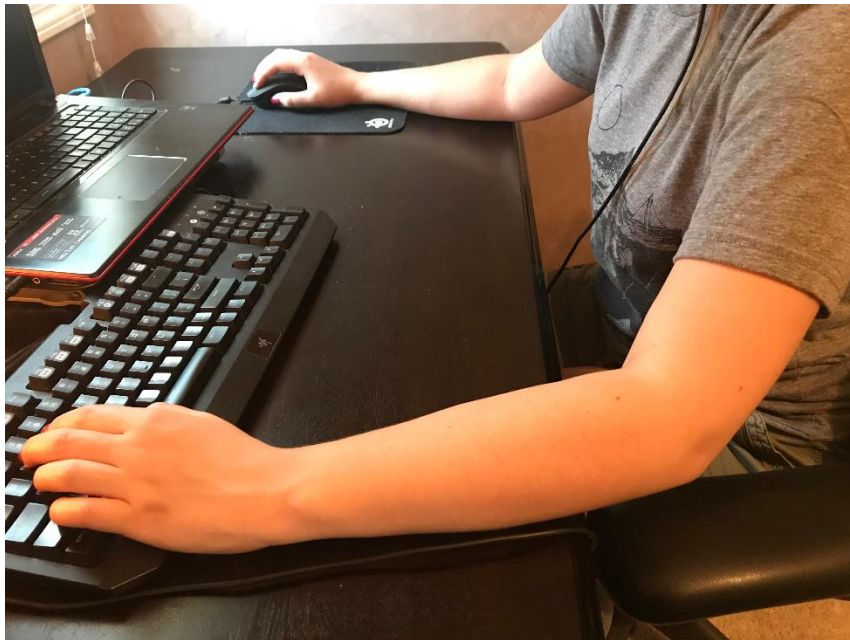


Figure 12. Elbows bent for playing PC eSports.



Figure 13. Elbow flexion displayed in occupations with high risk of cubital tunnel syndrome. Figures from carrickamadeus (2012) (left) and kentava-save (2015) (right).

Cubital tunnel syndrome could be a common RSI in console-based eSports, as players hold controllers by sustained elbow flexion. For longer practice or tournament sessions, players often begin to rest their elbows on their legs, armrests, or other surfaces while maintaining flexion, which further compresses the cubital tunnel (McGee, 2018). Vish Rajkumar, a competitive Super Smash Bros. Melee player, was diagnosed with cubital tunnel syndrome and stated that “during that whole year [of 2015], I had been practicing more than usual. Daily drills, playing a few times a week. . . . The pain started pretty randomly and suddenly, with nerve pain through my right hand,” (Funes, 2016, paragraph 14). After beginning physical therapy, Rajkumar was diagnosed with cubital tunnel syndrome

For PC gamers, cubital tunnel syndrome can occur when their forearms rest on their desk. Lewis “Comanglia” Robinson, a top player in the first-person shooter Team Fortress 2, described his injury: “Over the past year [of 2018] I’ve been having issues with my mouse hand pinky. Sometimes it just hurts a bit or it feels kinda numb but still

feel like I can feel things just fine just that it's not 'normal' [sic]" (Robinson, 2018).

Though Robinson was never diagnosed with cubital tunnel syndrome, he described his symptoms being alleviated once he stopped resting his elbow on his armrests or desk (Robinson, 2018).

CHAPTER FOUR

Guyon Canal Syndrome

Guyon canal syndrome (also known as ulnar tunnel syndrome or handlebar palsy) is a relatively uncommon RSI caused by the compression of the ulnar nerve within the Guyon canal (or ulnar tunnel) of the wrist. Like cubital tunnel syndrome, it is a compression syndrome of the ulnar nerve. However, Guyon canal syndrome can vary in symptoms dependent upon the site of compression. This is because the ulnar nerve branches into separate sensory and motor nerves within the Guyon canal (Katirji, 2016).

The Guyon canal walls are the hook of the hamate and the pisiform bones. The roof of the tunnel is the volar carpal ligament, while the floor is the transverse carpal ligament (Siaton and Flores, 2019). As the carpal tunnel's roof is the transverse carpal ligament, the Guyon canal is superficial to the carpal tunnel (Figure 4). There is some disagreement among anatomists about the correct boundaries of the Guyon canal (Maroukis et al., 2014), however, the most accepted definition separates the Guyon canal into three zones. These zones contain three sites of potential compression that match the three types of Guyon canal syndrome (Figure 14). Zone I begins at the proximal edge of the transverse carpal ligament and ends just before the branching point of the ulnar nerve. Zone II contains the deep branch of the ulnar nerve. It runs just distal to the branching point of the ulnar nerve to the fibrous arch of the hypothenar muscles.

Zone III contains the superficial branch of the ulnar nerve. It begins just distal to the branching point of the ulnar nerve and travels to ulnar half of fourth and fifth digit (Gross and Gelberman, 1985).

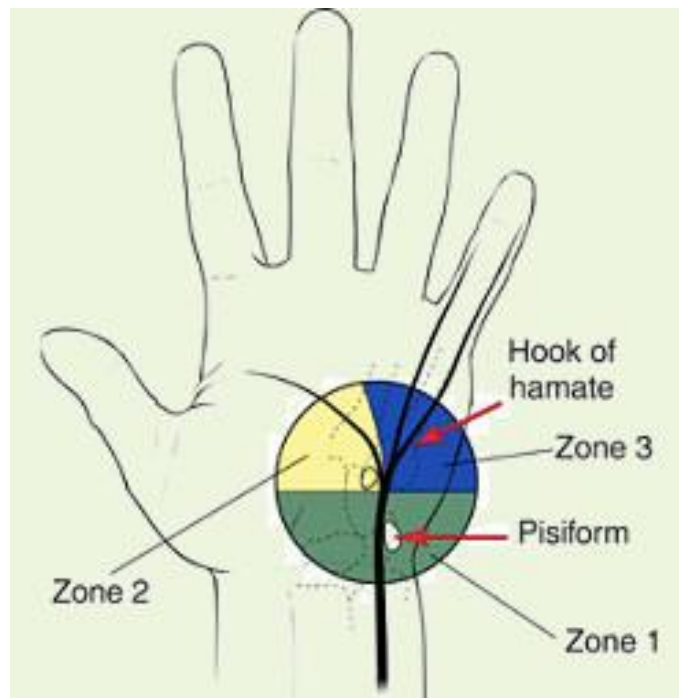


Figure 14. Zones of the Guyon canal. Figure from Masem (2011).

These three zones contain different branches of the ulnar nerve; at the end of zone I the ulnar nerve splits into the superficial ulnar nerve and the deep ulnar nerve. The superficial ulnar nerve carries the sensory information from the ulnar half of the fourth digit and the fifth digit, while the deep ulnar nerve innervates all interossei and the ulnar lumbricals of the ulnar half of the fourth and the fifth digit (Snow and Bunney, 2018).

Guyon canal syndrome is typically separated into different types, as the symptoms experienced will vary dependent upon the site of compression. Type I Guyon canal

syndrome is caused by a compression in zone I prior to the bifurcation into the superficial and deep ulnar nerve (point 1 on Figure 15), and will result in combined symptoms of both Type II and Type III Guyon canal syndrome (Vallarino and Santiago, 2019). This means Type I Guyon canal syndrome will have symptoms of numbness in the ulnar half of the fourth and the fifth digits, and loss of motor function. Type II Guyon canal syndrome will result in only the reduction of motor function, due to a compression in zone II (points 2 and 3 on Figure 15). There are multiple common sites of compression within zone II, resulting in varying degrees of motor function loss. In Type III Guyon canal syndrome, only numbness and pain in the ulnar half of the fourth digit and the fifth digit will occur due to a compression in zone III (point 4 on Figure 15). Diagnosis is typically determined by physical history along with ultrasonography, nerve conduction study and electromyography.

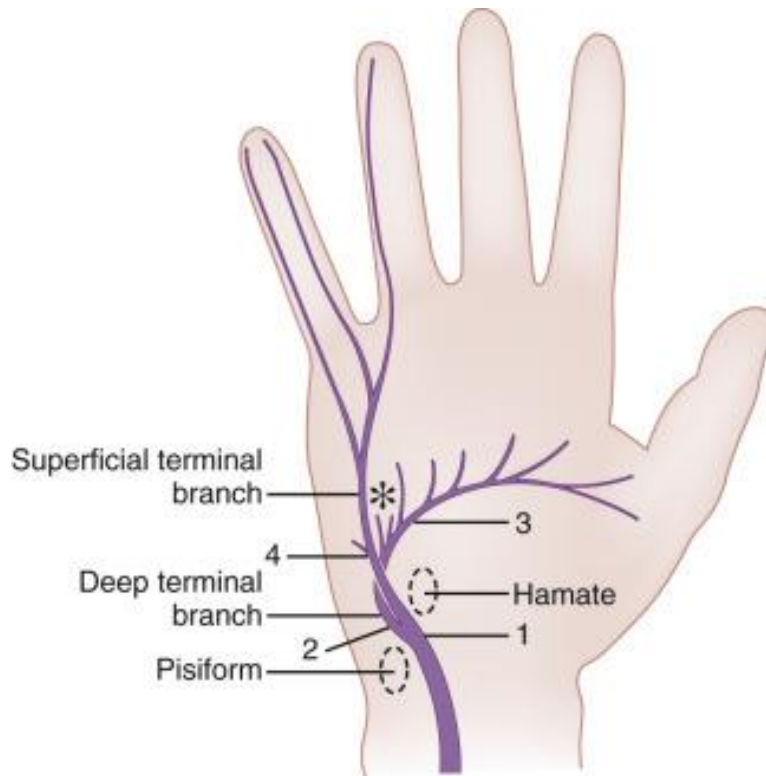


Figure 15. Common sites of compression of the ulnar nerve within the Guyon canal.

Figure from Snow and Bunney (2018).

The pathophysiology remains relatively the same; like in cubital tunnel syndrome, the branches of the ulnar nerve are the only content (besides fat) of the Guyon canal, meaning the primary cause of Guyon canal syndrome is external pressure. Unlike cubital tunnel syndrome, the canal is bounded by the hamate and pisiform which can exert pressure on the nerve when fractured. Risk for Guyon canal syndrome is increased with degenerative conditions (such as rheumatoid arthritis), as it reduces the size of the tunnel. The hypotheses for the symptoms experienced are focal demyelination at the points of compression and ischemia, just as with CTS and cubital tunnel syndrome (Kofler et al., 2019).

Guyon canal syndrome is caused primarily from sustained or repetitive pressure on the ulnar side of the hand (Hagert and Lalonde, 2018). This is common in cyclists and in individuals whose occupations require frequent use of hand tools (Hagert and Lalonde, 2018). The point of compression determines the type of the disorder, and which symptoms are experienced; this means that the mechanism of injury for each type of Guyon canal syndrome varies slightly depending upon where pressure is exerted during a gripping or grasping motion (Snow and Bunney, 2018).

Though there is no known documented evidence for Guyon canal syndrome caused by eSports, similar sustained pressure on the ulnar side of the hand is common in both console-based and PC video games. Players who tightly grip controllers (especially with a claw grip, Figure 16) sustain pressure on the ulnar side of the palm for the duration of practice. For PC games, the hand gripping the mouse often exerts the greatest pressure on the ulnar side of the hand. During any motion, especially under the stress of competition, the mouse is grasped more tightly. Though no prominent eSports players have mentioned their diagnosis with it, casual video game players have described having ulnar half of the fourth and fifth digit numbness and pain (Khan, 2016; Ince et al., 2017). In addition, one case of Guyon canal syndrome has been deemed “Video Game Palsy” (Friedland and St. John, 1984).

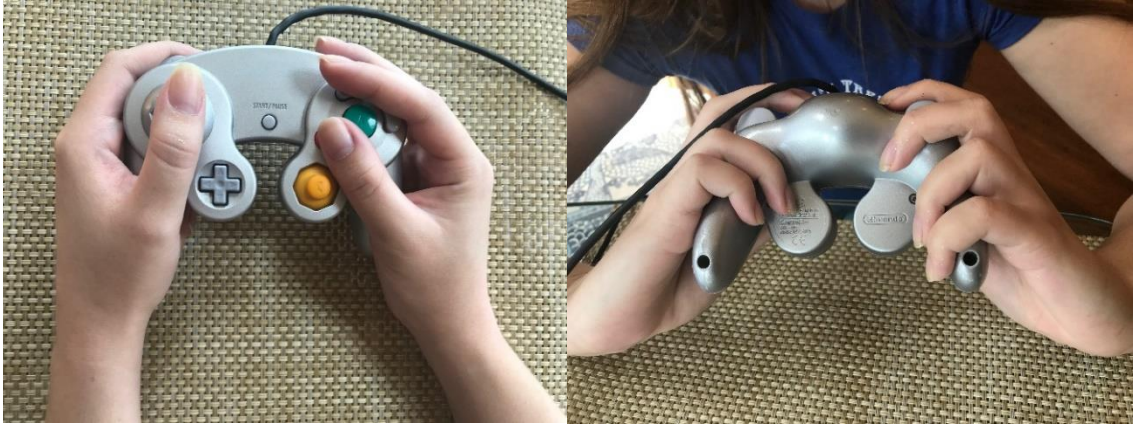


Figure 16. Claw grip of Nintendo Gamecube controller.

CHAPTER FIVE

Conclusion

There is reasonable cause to research RSIs of nervous tissue in eSports from firsthand accounts. The biological basis of nerve entrapment syndromes relates compression to axonal attenuation. As the motions in eSports cause similar compression, a link may potentially be established between eSports players and the described RSIs of nervous tissue (CTS, cubital tunnel syndrome, and Guyon canal syndrome). In fact, many players have already been diagnosed with these RSIs (Gaudiosi, 2018).

Though there is little research in this area so far, what has been studied supports the hypothesis that RSIs can be caused by eSports (DiFrancisco-Donoghue et al., 2018). The lack of research despite the frequent discussion of injury within the eSports community likely means the problem is underdiagnosed. As the eSports industry continues to grow and more players participate, it is likely that more people will be putting themselves at risk of these RSIs.

Further research could include an overview of tendon and muscular injuries that may be caused by eSports. In addition, researchers could focus study on eSports athletes to determine their risk for specific RSIs. Research into the prevention of these RSIs could lead to the development of ergonomic devices for eSports competitors to reduce the occurrence of injury.

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